Are We There Yet?
IPv6 as Related to GDP per Capita

Alain Durand, September 23rd 2016

Questions for this Study:

I. **Where are we across the globe with IPv6 adoption?**
   a. Is IPv6 deployed uniformly?
   b. Is there a rich country/poor country divide?

II. **What can IPv6 adoption numbers tell us about IPv6 as a replacement for IPv4?**
   a. How to best measure IPv6 adoption? Penetration or usage? How do they differ?
   b. Are we there yet? (As in, can we retire IPv4?)

Methodology

I. **Find data about IPv6 adoption per country**
   - Penetration data
   - Bandwidth data

II. **Compare countries**
   - Use GDP per capita to characterize countries
     - Gross Domestic Product divided by population size
     - Metric widely use by economists to compare countries
   - Look at outliers

III. **Assessment of the data**
   - Are the various data set telling the same story?
   - Are we there yet?

Find data about IPv6 adoption per country

Data Sources

I. **APNIC/Geoff Huston IPv6 penetration study**

- Uses Google ads
- Provide a proxy* for measuring penetration, i.e. the potential of using IPv6 per country

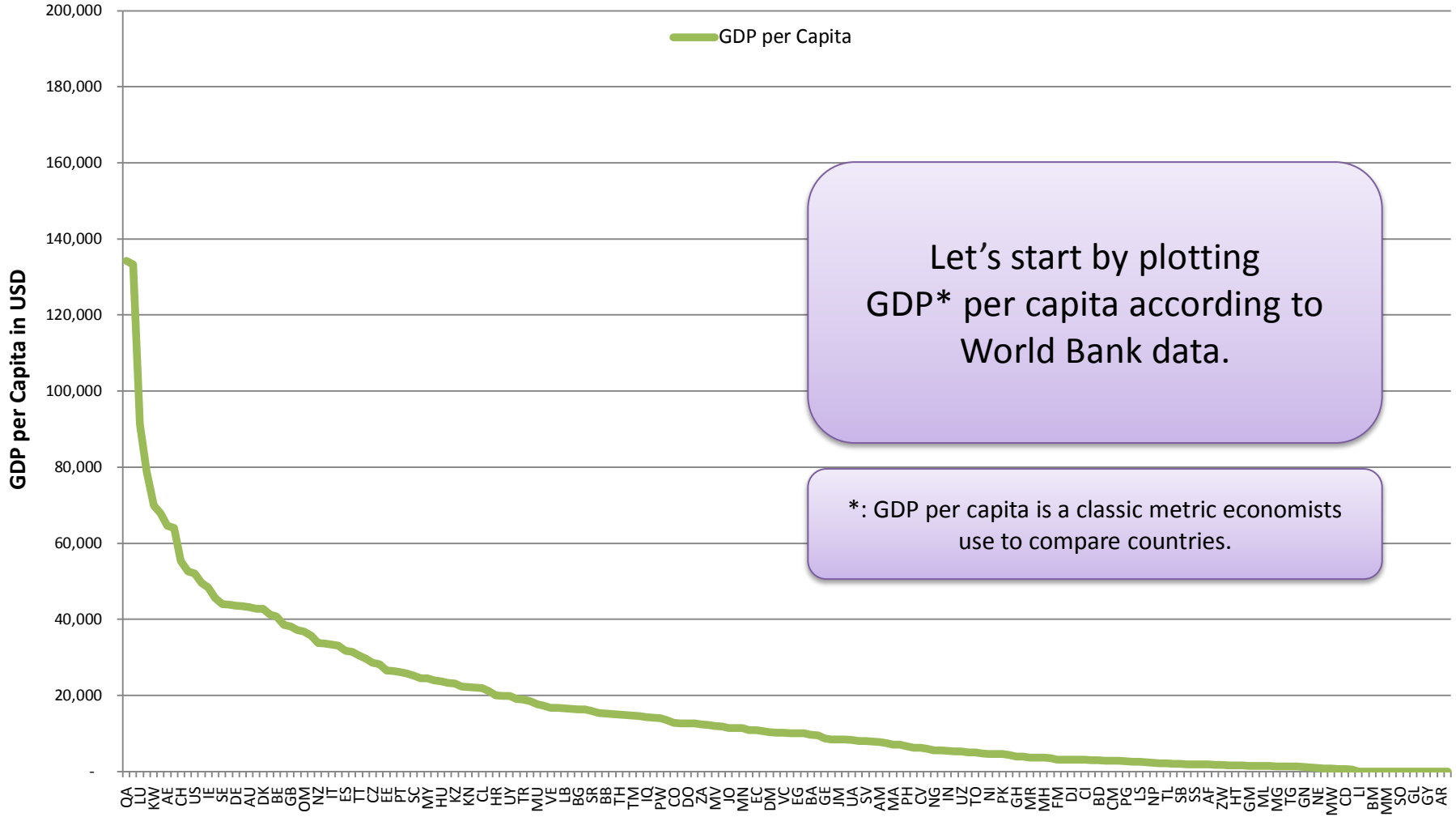
II. **AKAMAI State of the Internet study**

- Measure hits over IPv6 on Akamai caches
- Provide a proxy* for measuring bandwidth, i.e. the usage of IPv6 per country

* Proxy: a figure that can be used to represent the value of something in a calculation

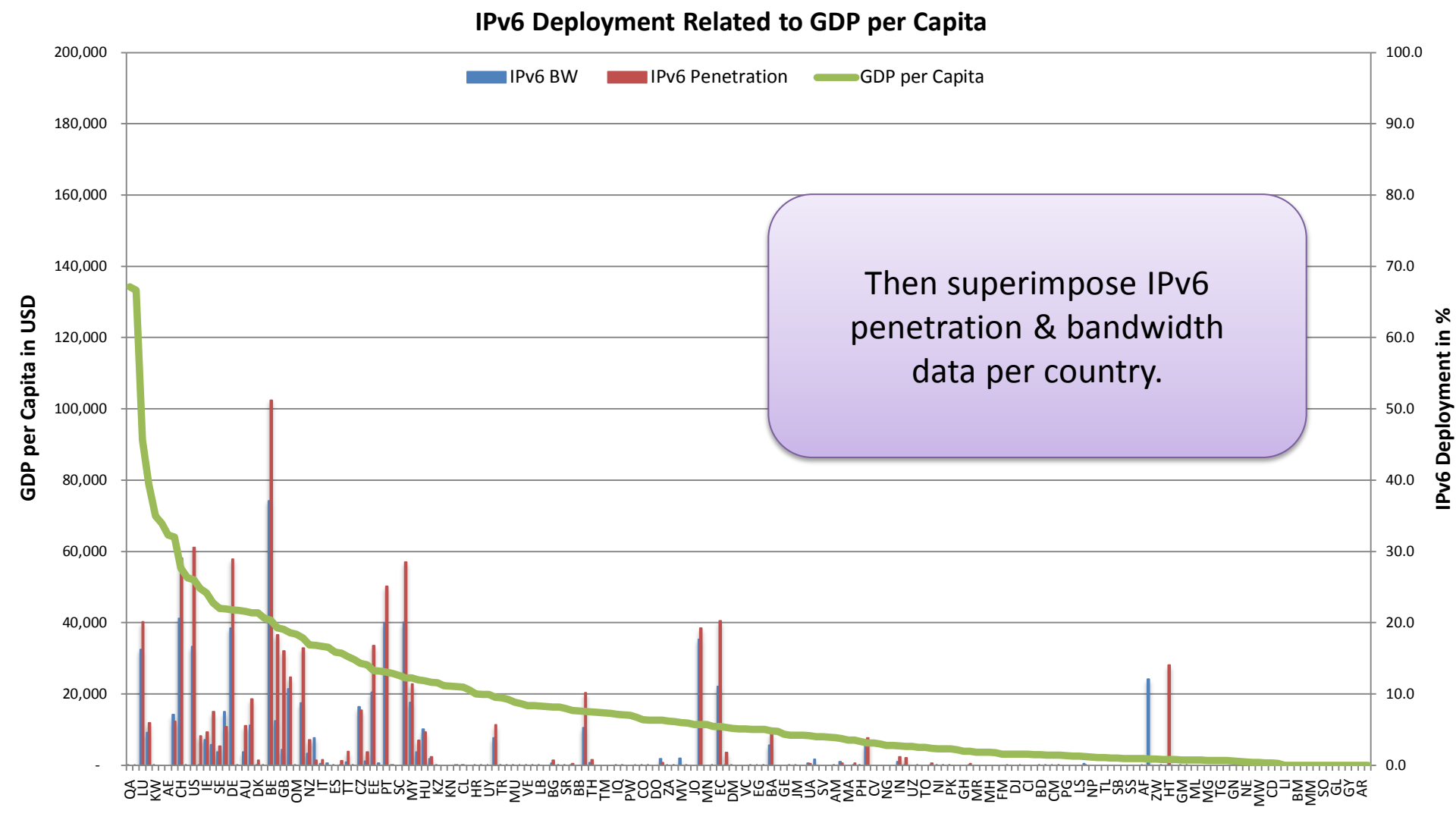
Where are we across the globe with IPv6 adoption?

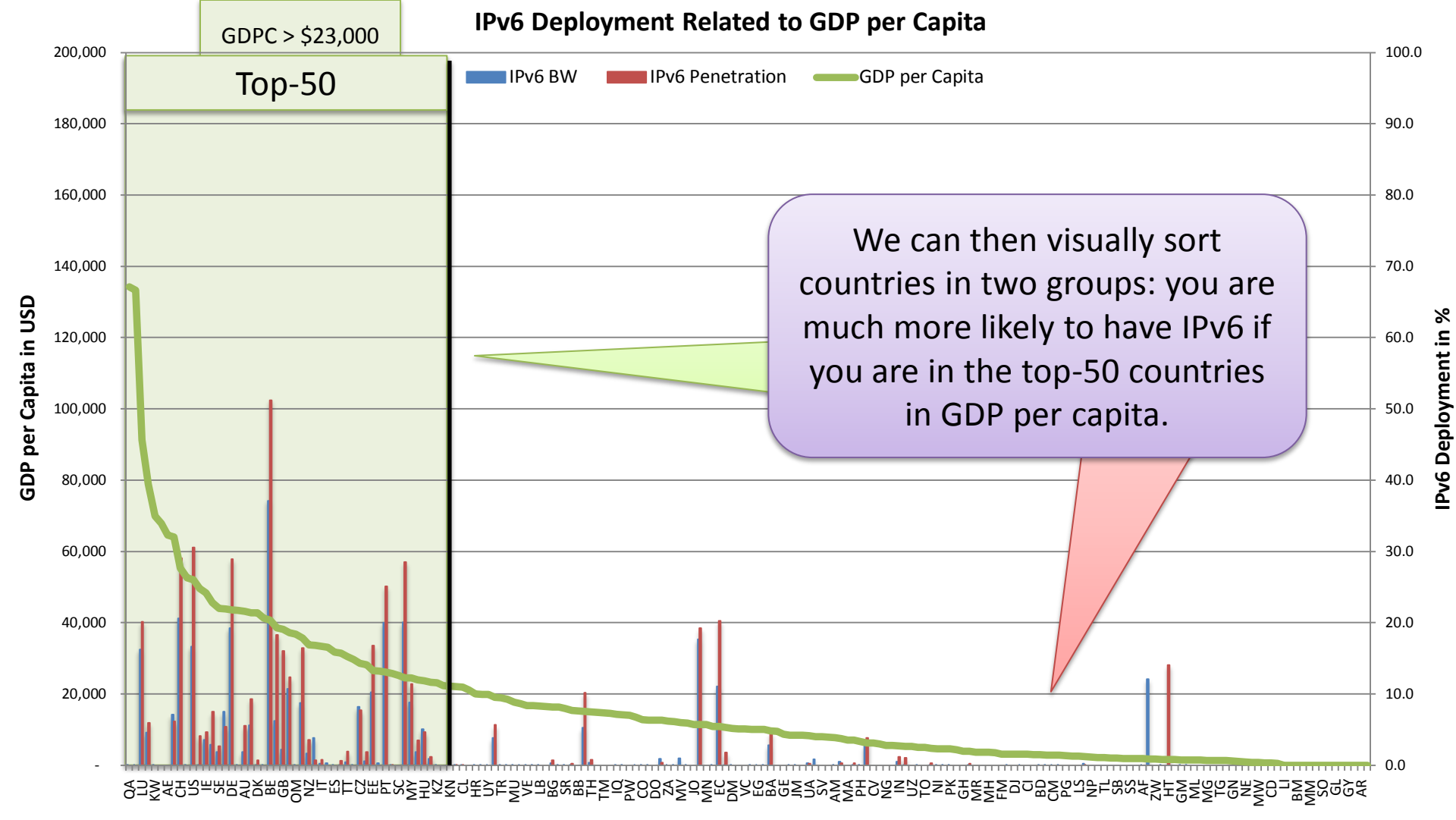
IPv6 Deployment Related to GDP per Capita



Let's start by plotting GDP* per capita according to World Bank data.

*: GDP per capita is a classic metric economists use to compare countries.


IPv6 Deployment Related to GDP per Capita
IPv6 BW
IPv6 Penetration
GDP per Capita
GDP per Capita in USD
IPv6 Deployment in %
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Then superimpose IPv6 penetration & bandwidth data per country.
QA LU KW AE CH US IE SE DE AU DK BE GB OM NZ IT ES TT CZ EE PT SC MY HU KZ KN CL HR UY TR MU VE LB BG SR BB TH TM IQ PW CO DO ZA MV JO MN EC DM VC EG BA GE JM UA SV AM MA PH CV NG IN UZ TO NI PK GH MR MH FM DJ CI BD CM PG LS NP TL SB SS AF ZW HT GM ML MG TG GN NE MW CD LI BM MM SO GL GY AR


IPv6 Deployment Related to GDP per Capita
GDPC > $23,000
Top-50
IPv6 BW
IPv6 Penetration
GDP per Capita
We can then visually sort countries in two groups: you are much more likely to have IPv6 if you are in the top-50 countries in GDP per capita.
GDP per Capita in USD
IPv6 Deployment in %
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
100.0
90.0
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50.0
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30.0
20.0
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0.0
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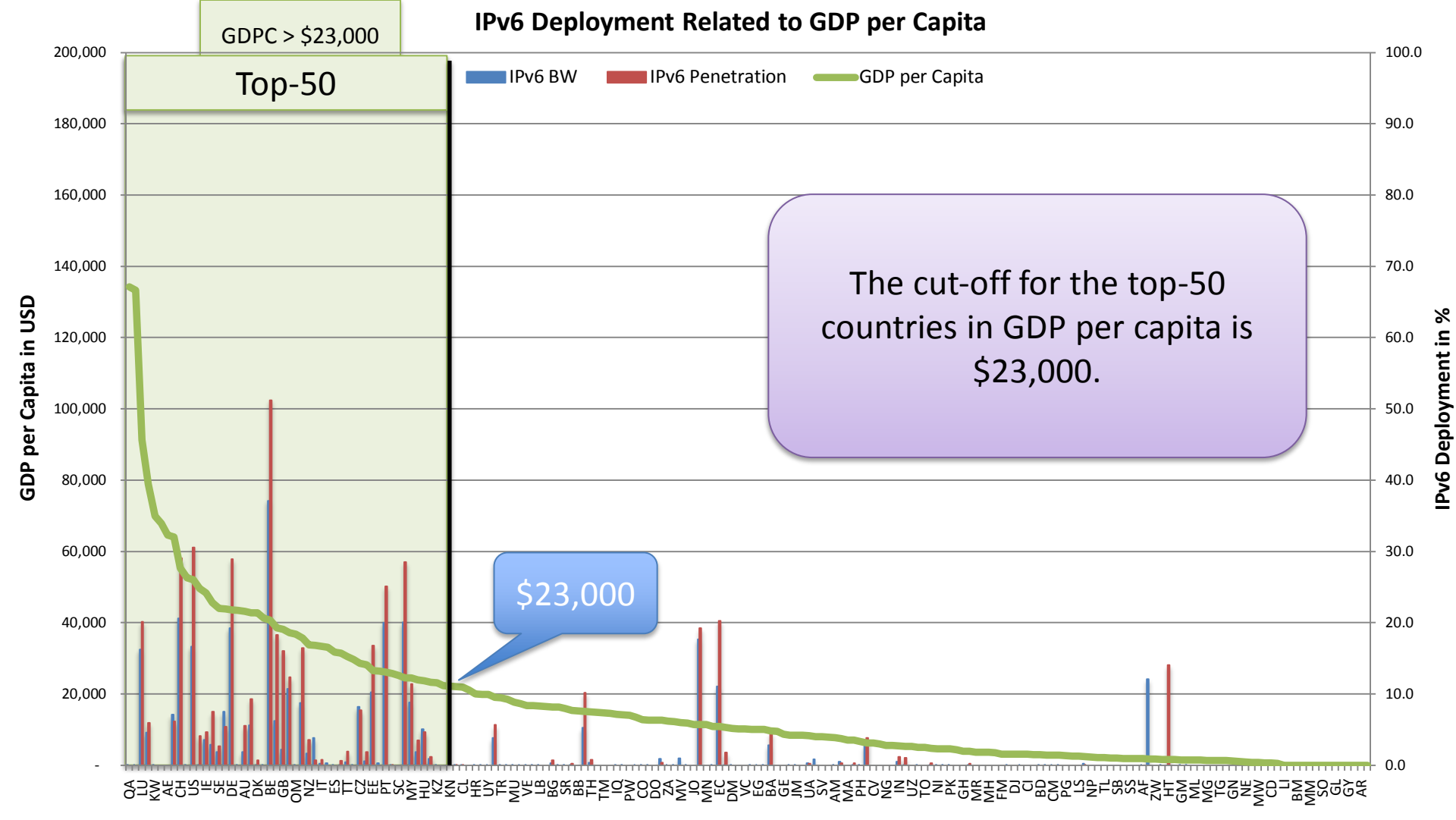
IPv6 Deployment Related to GDP per Capita
GDPC > $23,000
Top-50
IPv6 BW
IPv6 Penetration
GDP per Capita
The cut-off for the top-50 countries in GDP per capita is $23,000.
$23,000
GDP per Capita in USD
IPv6 Deployment in %
200,000
180,000
160,000
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120,000
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60.0
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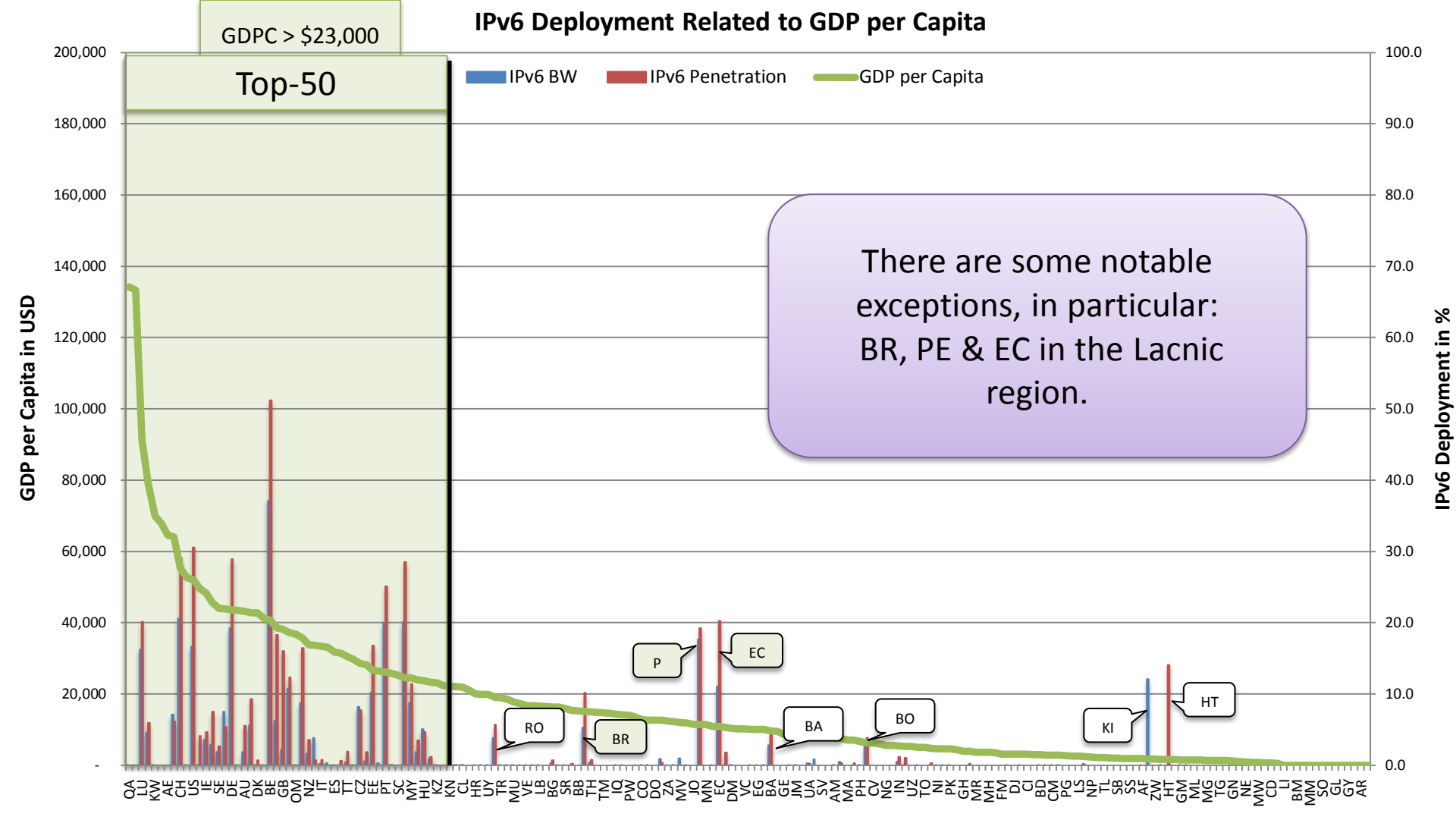
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70.0
60.0
50.0
40.0
30.0
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10.0
0.0
There are some notable exceptions, in particular: BR, PE & EC in the Lacnic region.
RO
BR
P
EC
BA
BO
KI
HT
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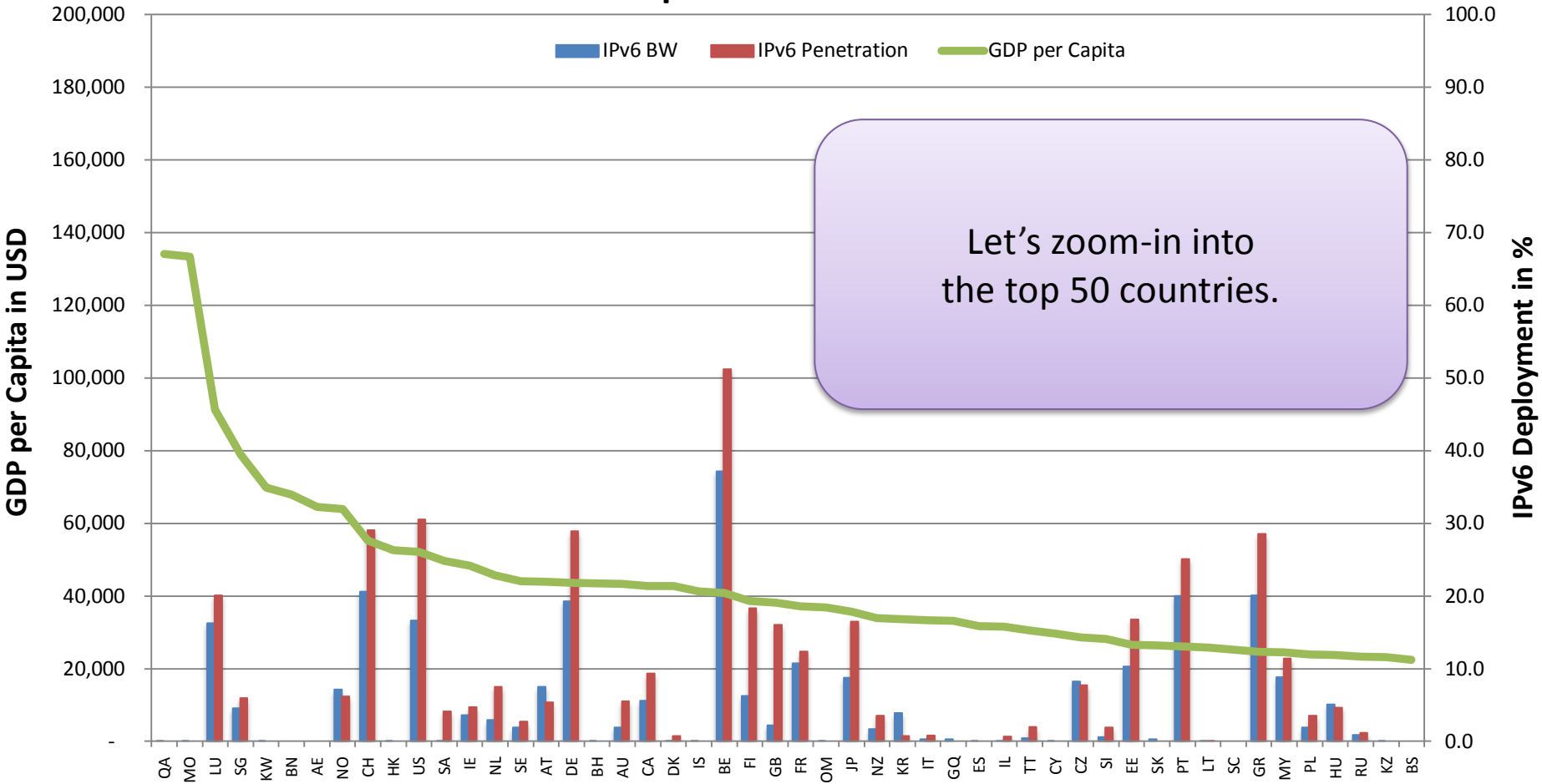
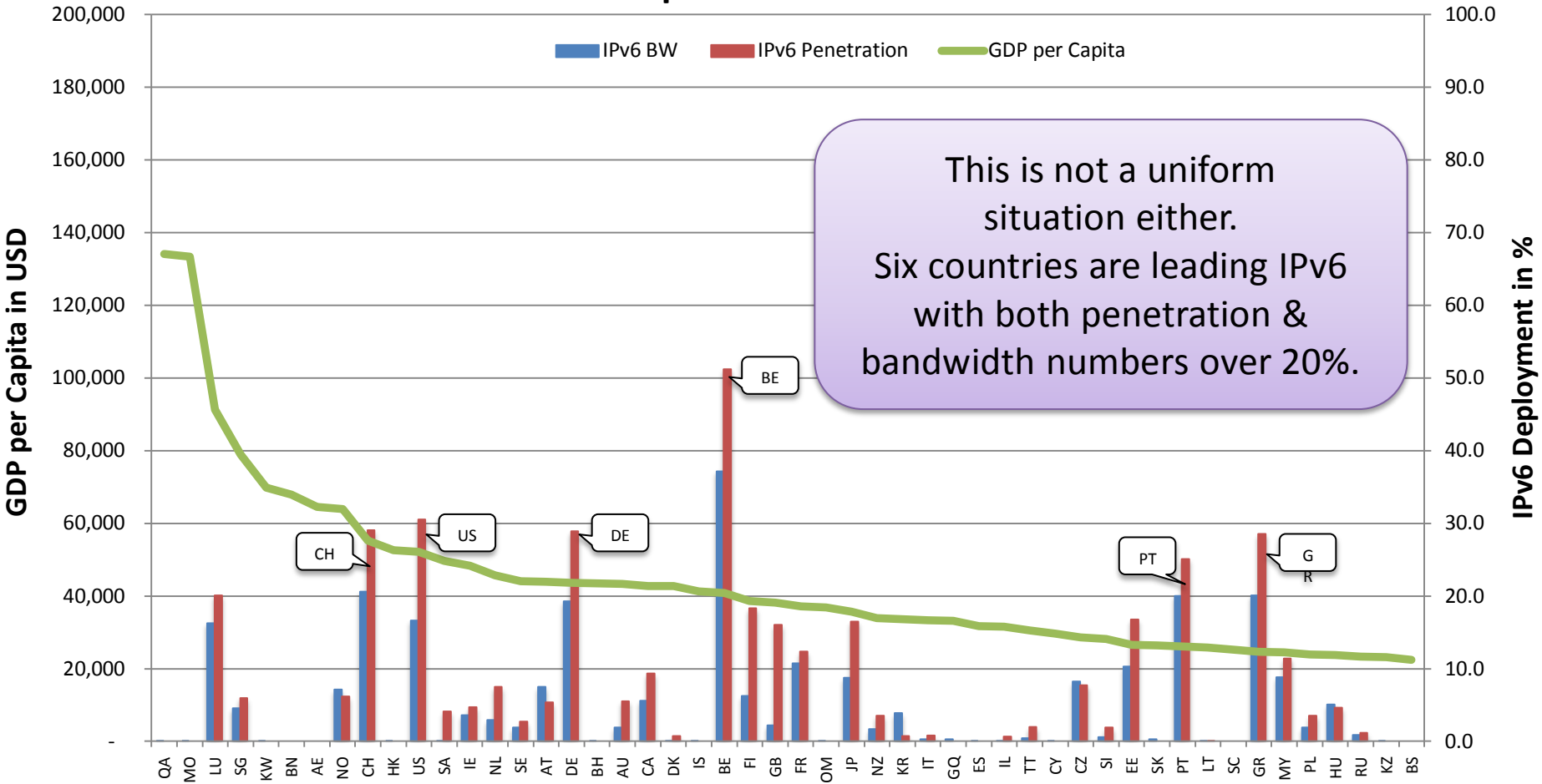
IPv6 Deployment Related to GDP per Capita
Top-50 Countries



IPv6 Deployment Related to GDP per Capita
Top-50 Countries



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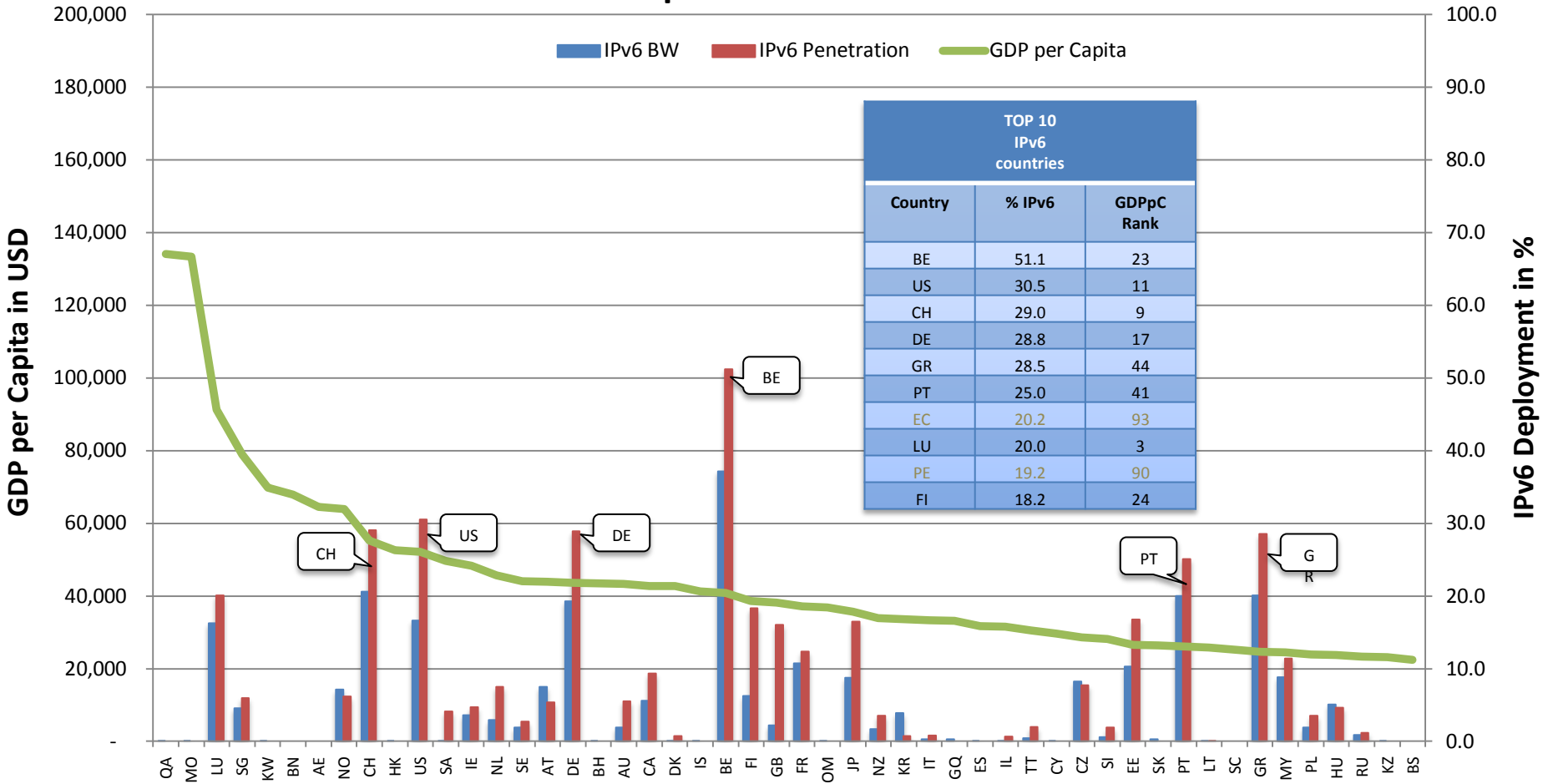
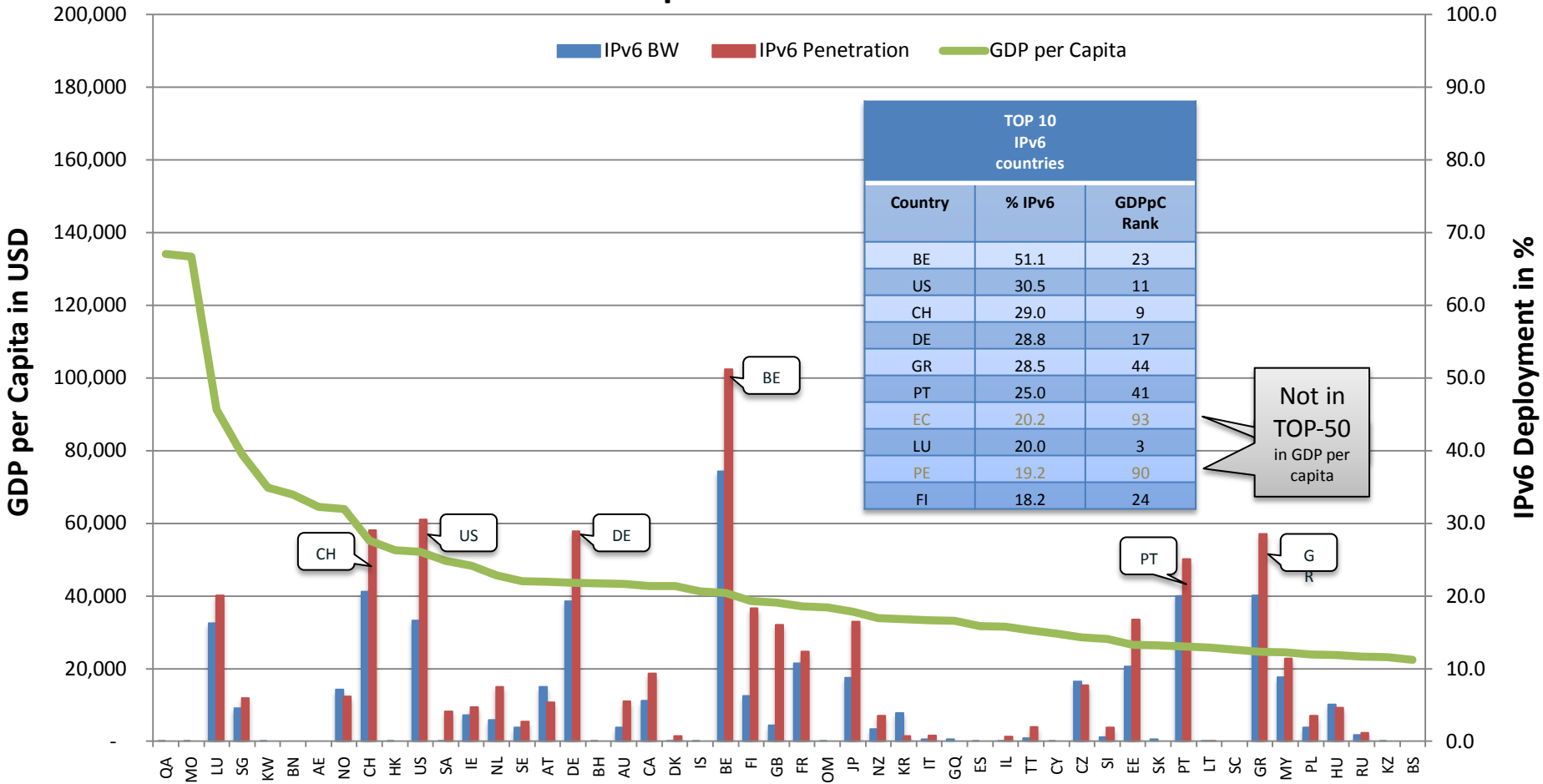
Top-50 Countries



TOP 10 IPv6 countries		
Country	% IPv6	GDPpC Rank
BE	51.1	23
US	30.5	11
CH	29.0	9
DE	28.8	17
GR	28.5	44
PT	25.0	41
EC	20.2	93
LU	20.0	3
PE	19.2	90
FI	18.2	24

IPv6 Deployment Related to GDP per Capita
Top-50 Countries



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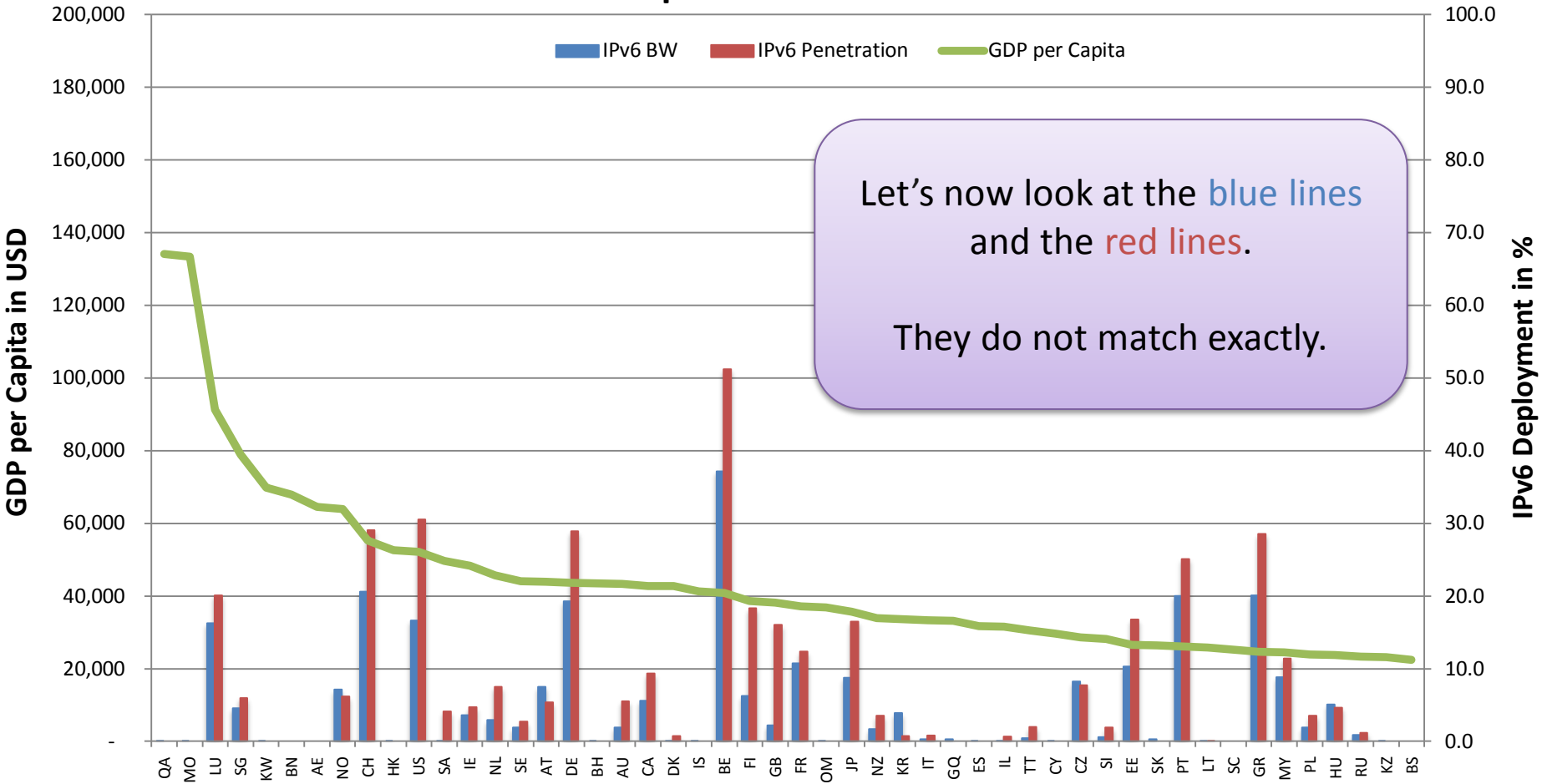
Not in TOP-50 in GDP per capita

Assessment of the data

IPv6 Deployment Related to GDP per Capita
Top-50 Countries

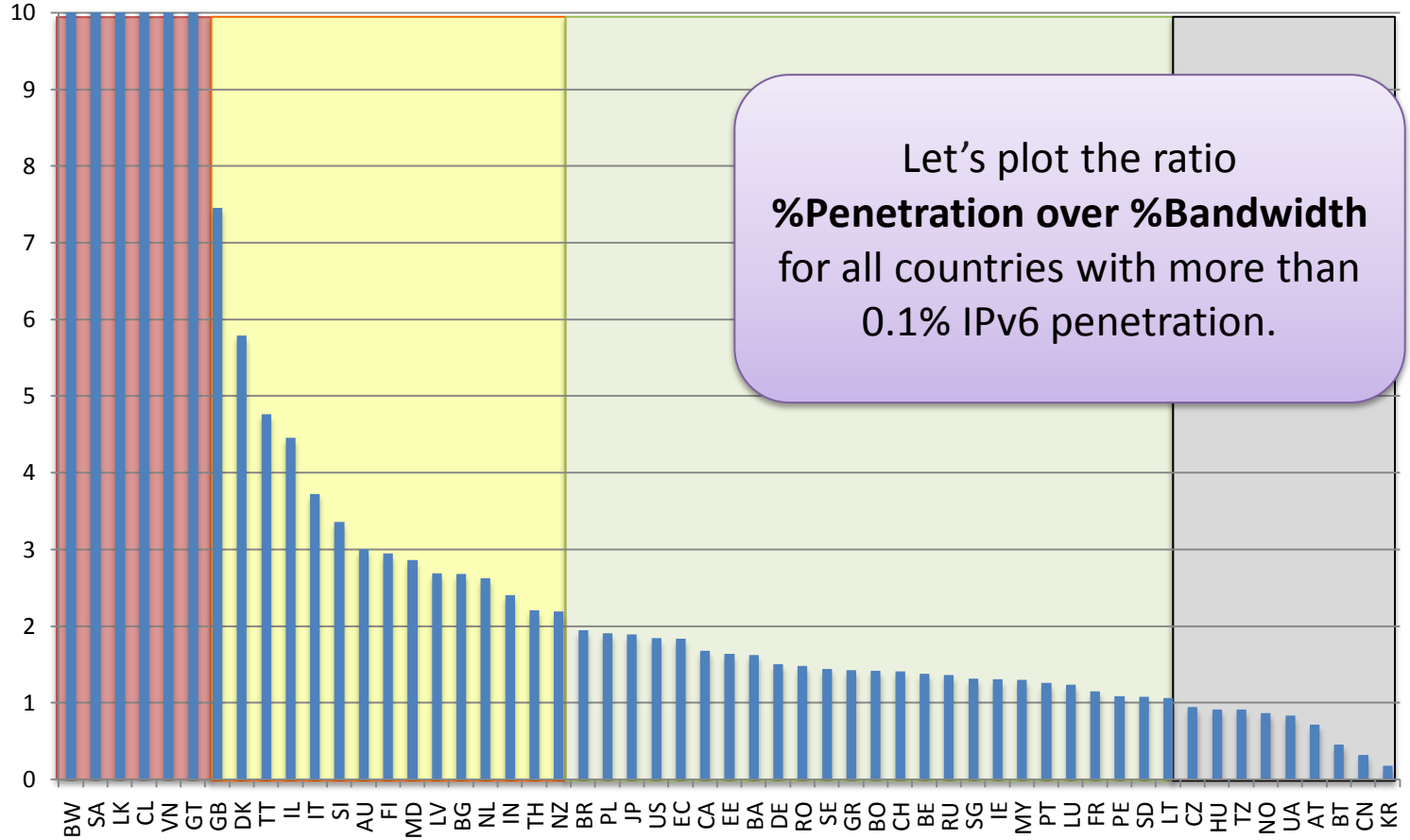


Let's now look at the blue lines and the red lines.

They do not match exactly.

IPv6 Penetration vs Usage:

%Penetration / %Bandwidth



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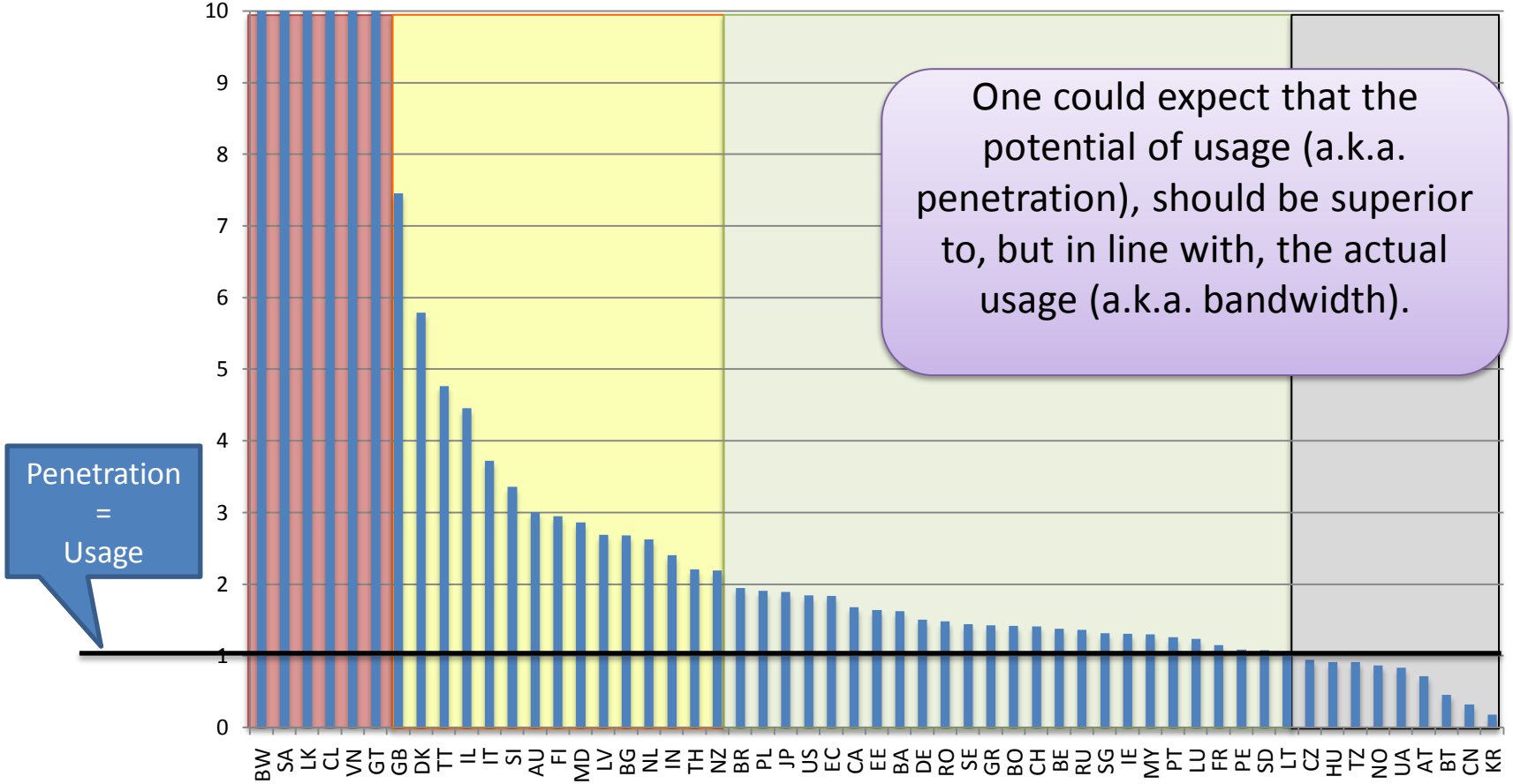
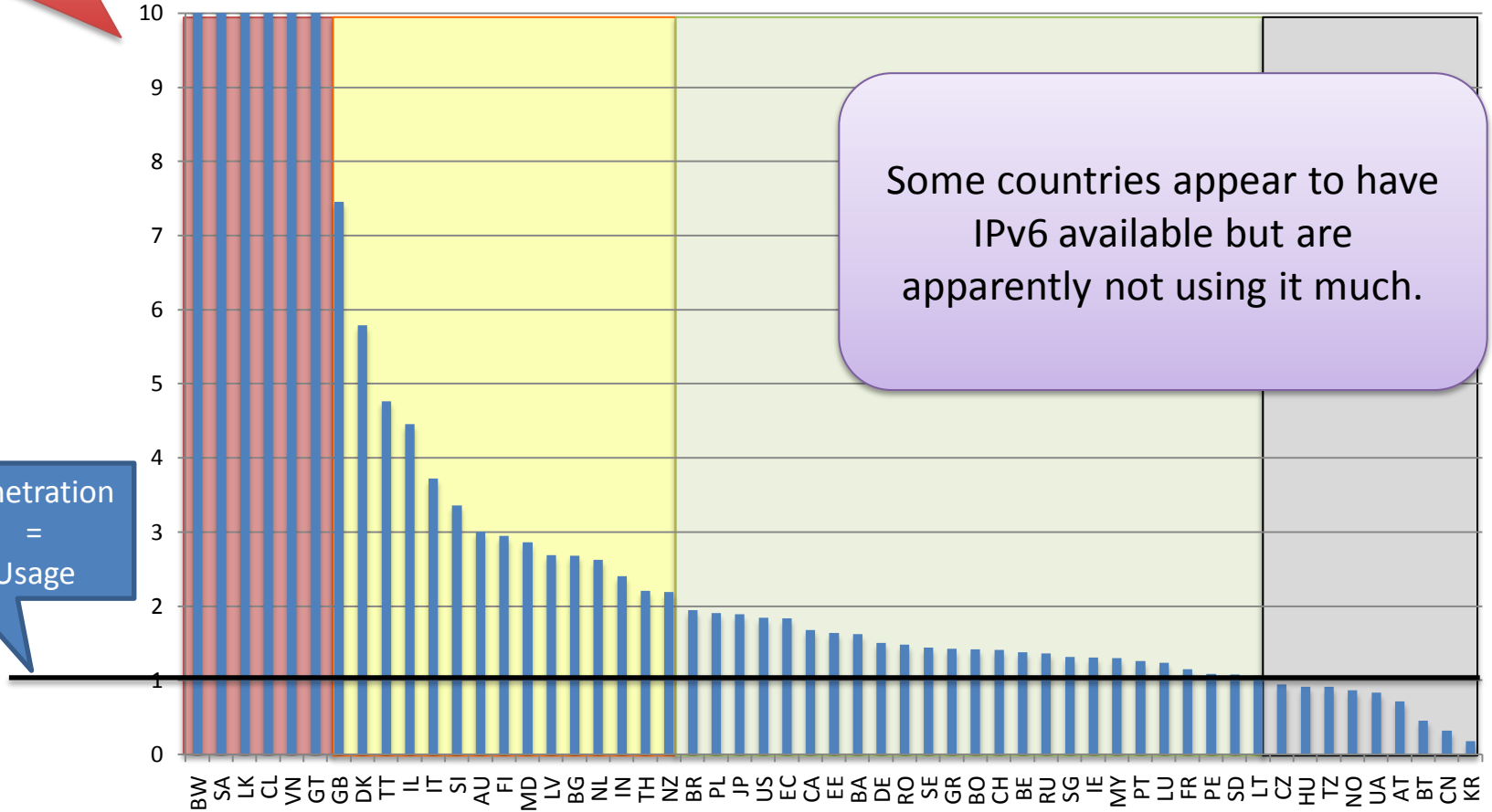


IPv6 Penetration vs Usage:

%Penetration / %Bandwidth

Off the chart:
IPv6 is available but not used: x15 to x900

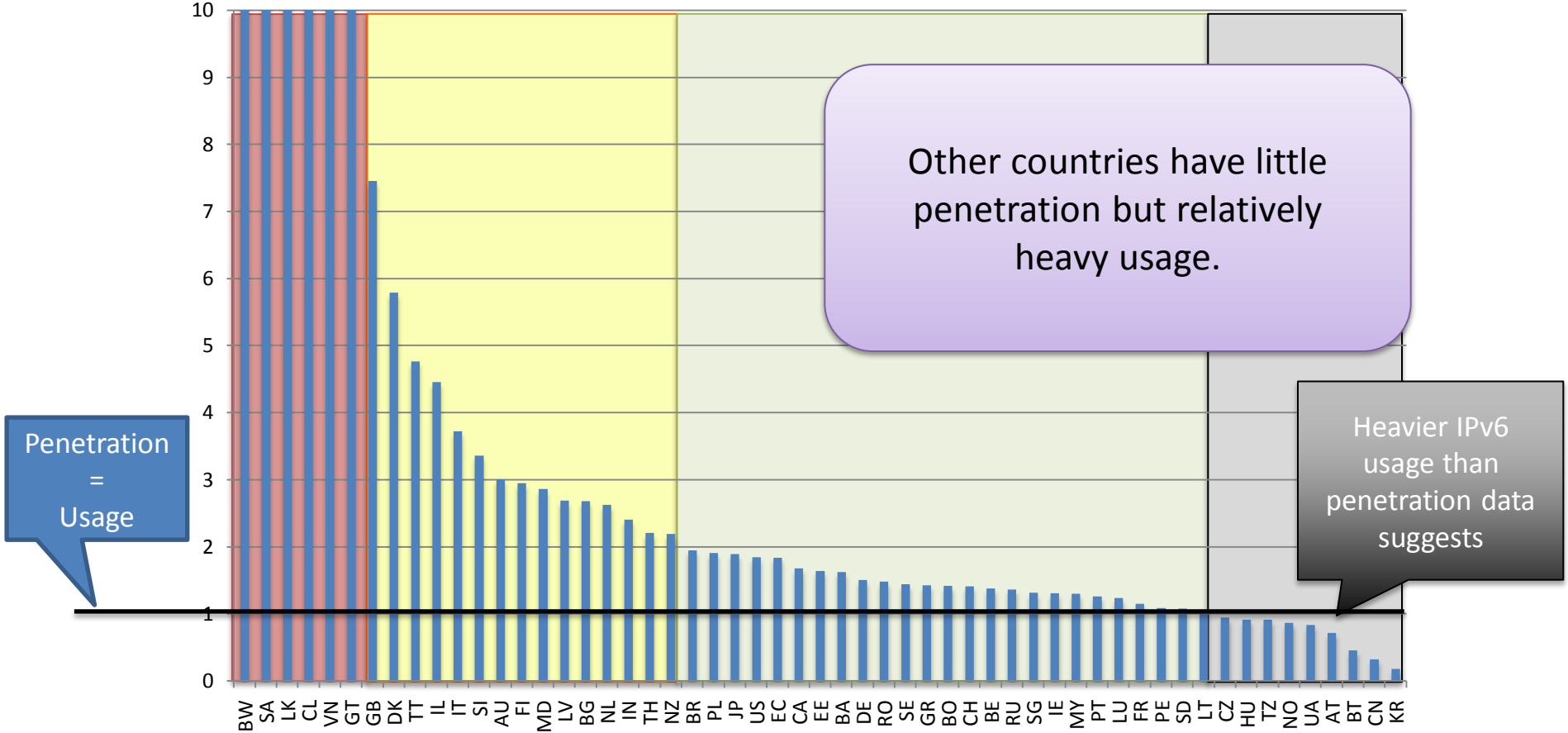


Some countries appear to have IPv6 available but are apparently not using it much.

Penetration = Usage

IPv6 Penetration vs Usage:

%Penetration / %Bandwidth



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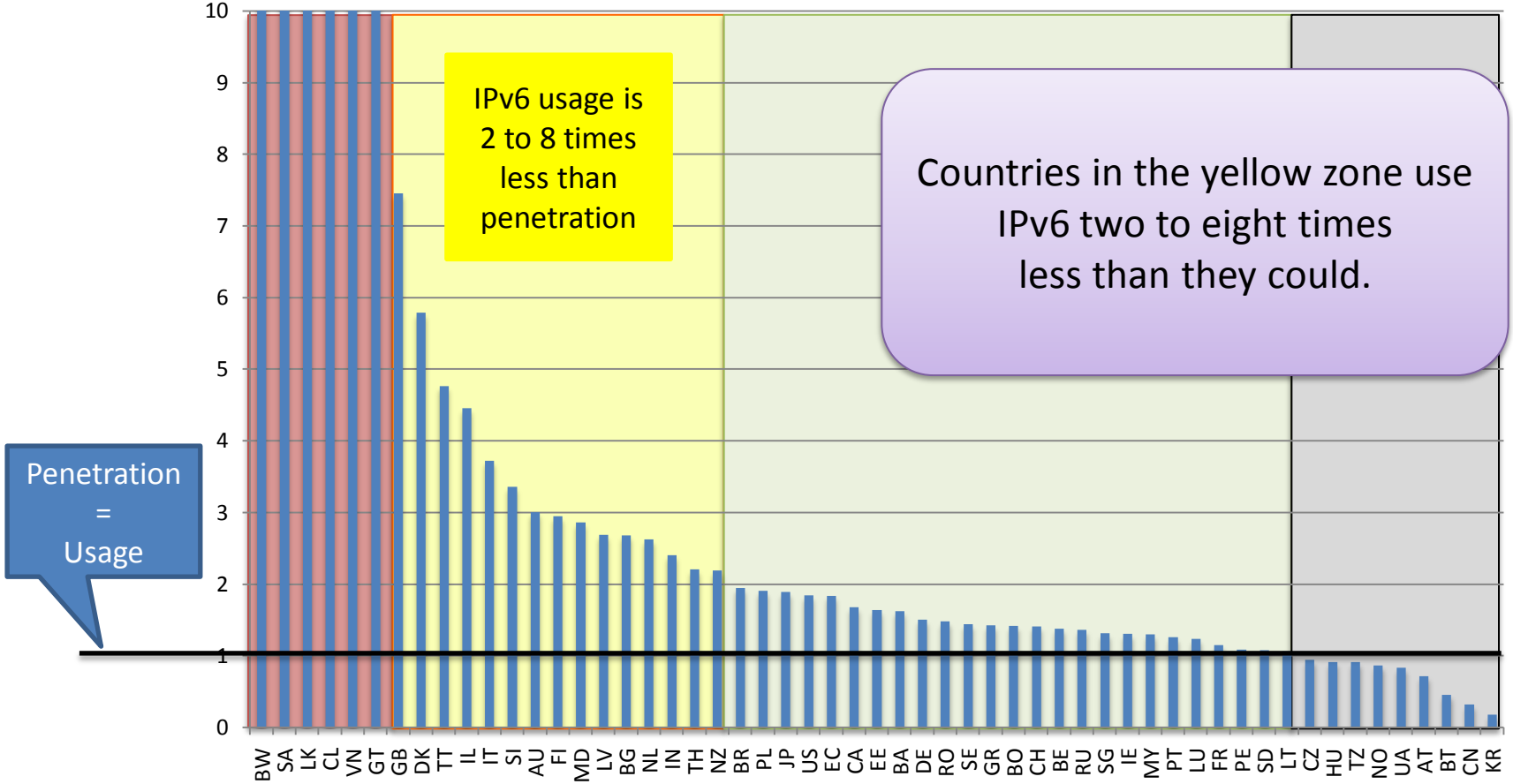

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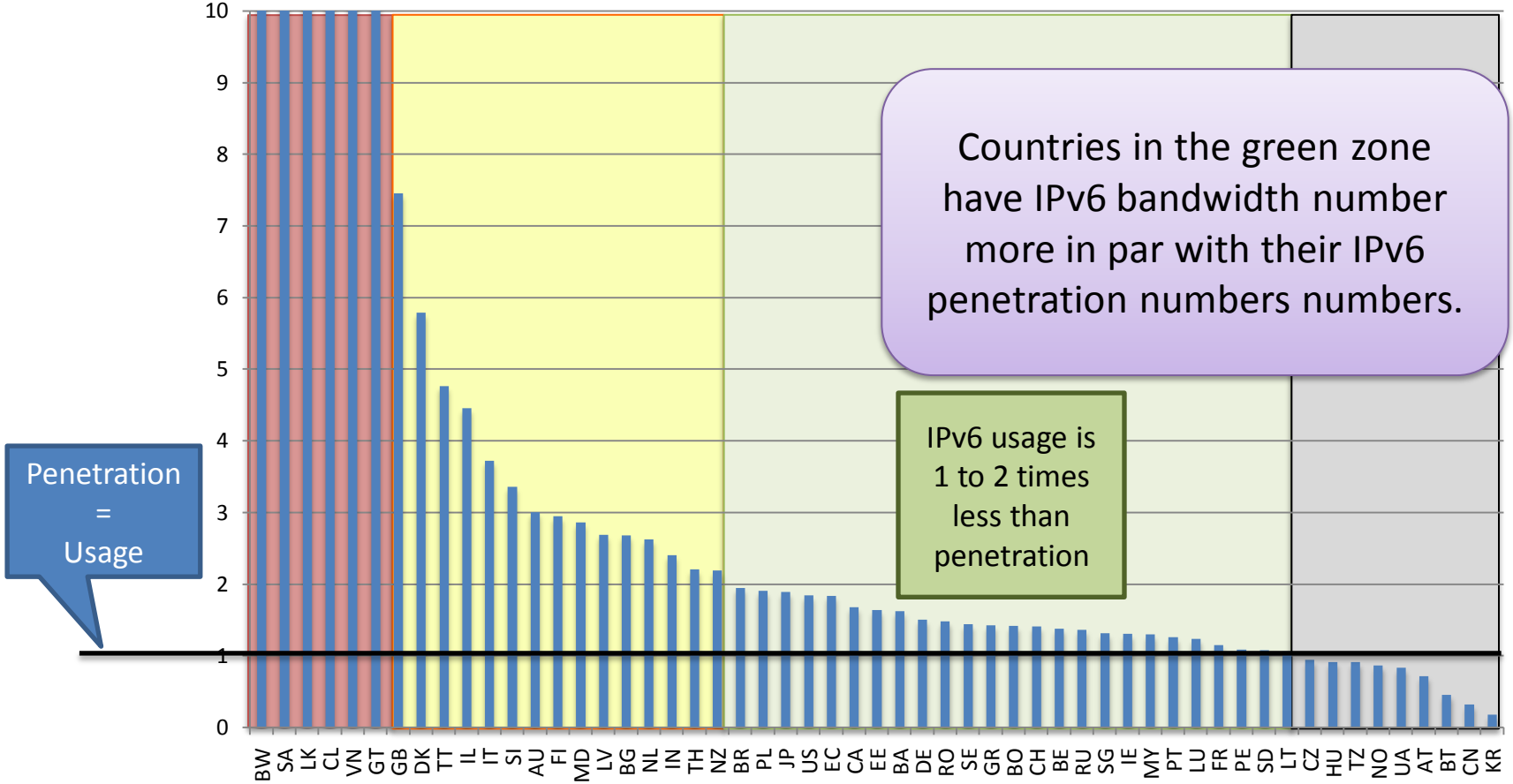

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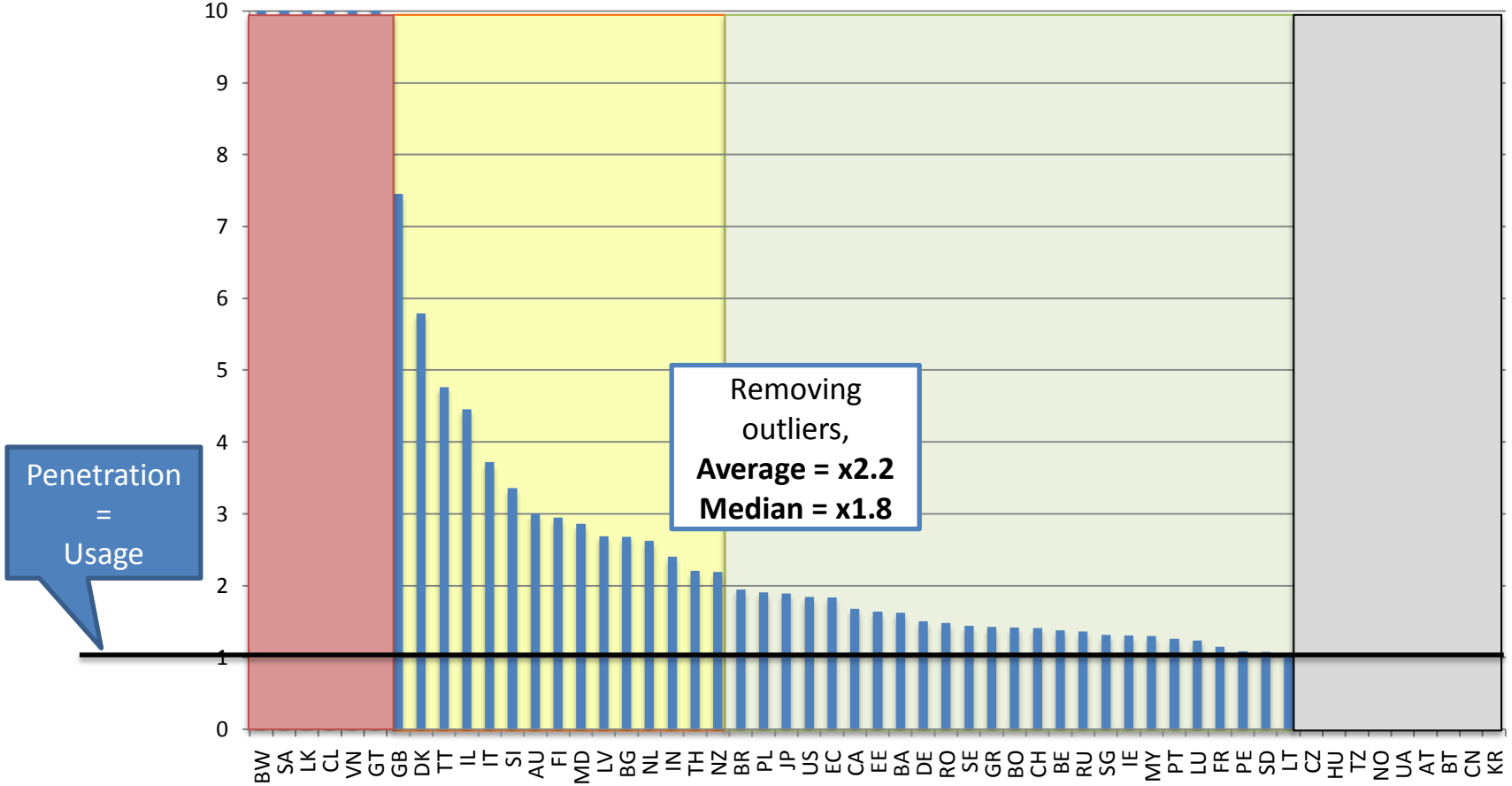

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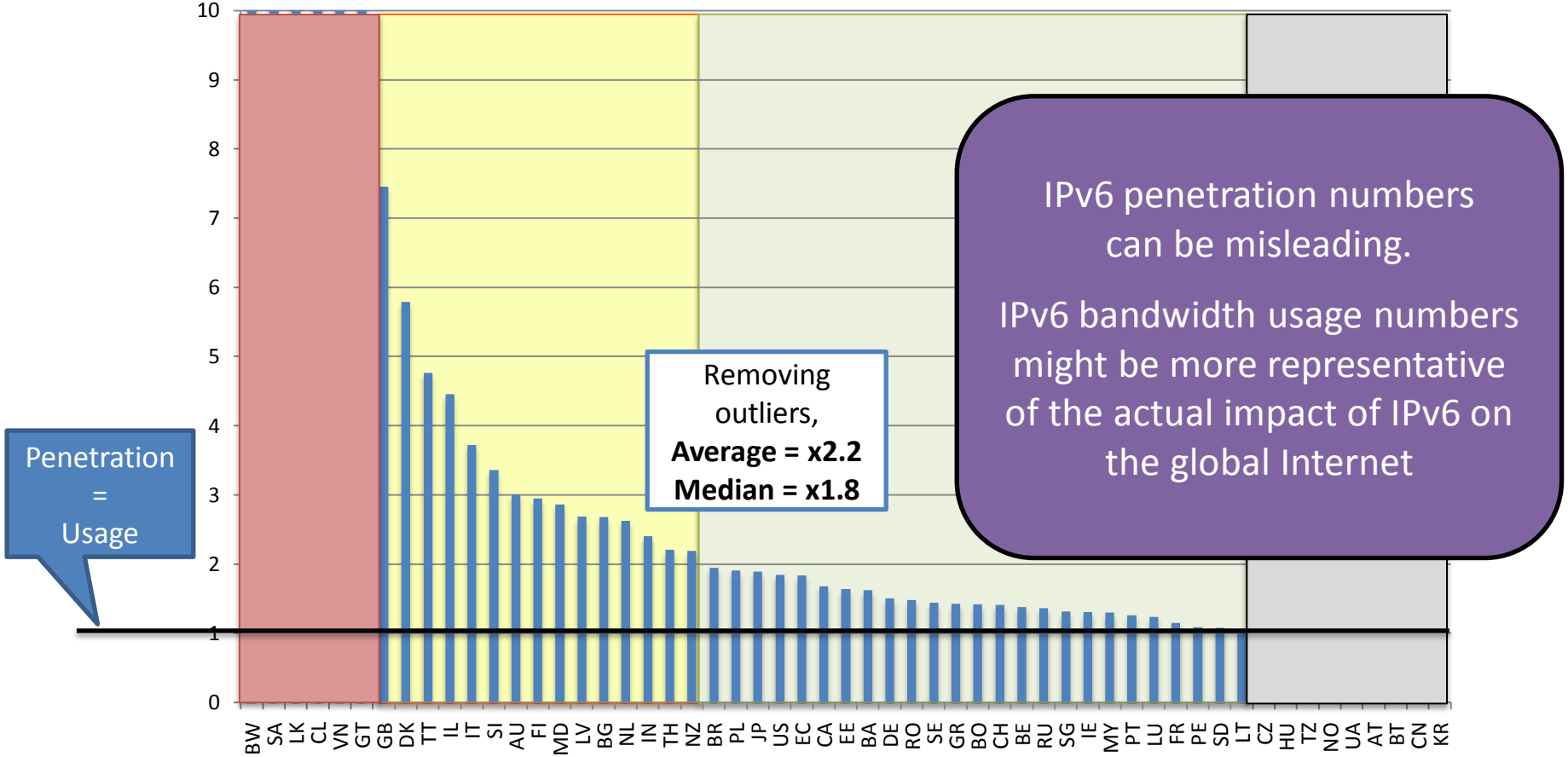

Are We There Yet?

A.k.a. Is IPv6 a viable replacement for IPv4?

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A.k.a. Is IPv6 a viable replacement for IPv4?

I. **No**

I. **There are positive signs**

- Six countries have both penetration and bandwidth numbers over 20%.

II. **IPv4 will still be very relevant for a long while**

- The large number of countries with low GDP per capita that have very little or no IPv6 should tempers enthusiasm.

Raw Data

Raw Data: Top-50 Countries (GDP per Capita)

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
QA	134,182	0.0	0.0
MO	133,341	0.0	0.0
LU	91,368	16.2	20.0
SG	78,958	4.5	5.9
KW	69,878	0.0	0.0
BN	67,912	0.0	0.0
AE	64,563	0.0	0.0
NO	63,999	7.0	6.1
CH	55,275	20.5	29.0
HK	52,552	0.1	0.0

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
US	52,118	16.6	30.5
SA	49,619	0.0	4.1
IE	48,400	3.5	4.6
NL	45,662	2.8	7.4
SE	44,004	1.8	2.6
AT	43,849	7.4	5.3
DE	43,559	19.2	28.8
BH	43,408	0.0	0.0
AU	43,256	1.8	5.5
CA	42,774	5.5	9.3

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
DK	42,765	0.1	0.7
IS	41,262	0.1	0.0
BE	40,802	37.1	51.1
FI	38,550	6.2	18.2
GB	38,149	2.1	16.0
FR	37,208	10.7	12.3
OM	36,855	0.0	0.0
JP	35,635	8.7	16.4
NZ	33,846	1.6	3.5
KR	33,629	3.8	0.7

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
IT	33,336	0.2	0.7
GQ	33,142	0.2	0.0
ES	31,753	0.1	0.0
IL	31,483	0.1	0.6
TT	30,497	0.4	1.9
CY	29,673	0.0	0.0
CZ	28,675	8.1	7.7
SI	28,156	0.5	1.8
EE	26,594	10.2	16.7
SK	26,470	0.2	0.0

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
PT	26,175	19.9	25.0
LT	25,786	0.1	0.1
SC	25,207	0.0	0.0
GR	24,570	20.0	28.5
MY	24,460	8.8	11.4
PL	23,966	1.8	3.5
HU	23,731	5.0	4.6
RU	23,293	0.8	1.1
KZ	23,114	0.0	0.0
BS	22,411	0.0	0.0

Raw Data: 51-100 Countries (GDP per Capita)

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
KN	22,171	0.0	0.0
LV	22,038	0.0	0.1
CL	21,980	0.0	0.1
AG	21,062	0.0	0.0
HR	20,033	0.1	0.0
PA	19,934	0.0	0.0
UY	19,924	0.0	0.0
RO	19,104	3.8	5.6
TR	18,869	0.0	0.0
GA	18,537	0.0	0.0

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
MU	17,731	0.0	0.0
BY	17,349	0.0	0.0
VE	16,751	0.0	0.0
AZ	16,715	0.0	0.0
LB	16,659	0.0	0.0
IR	16,507	0.0	0.0
BG	16,363	0.2	0.7
MX	16,284	0.0	0.0
SR	15,873	0.0	0.0
BW	15,359	0.0	0.2

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
BB	15,320	0.0	0.0
BR	15,162	5.2	10.1
TH	15,012	0.3	0.7
LY	14,880	0.0	0.0
TM	14,762	0.0	0.0
ME	14,534	0.0	0.0
IQ	14,365	0.0	0.0
CR	14,232	0.0	0.0
PW	14,078	0.0	0.0
DZ	13,541	0.0	0.0

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
CO	12,743	0.0	0.0
RS	12,717	0.1	0.0
DO	12,653	0.0	0.0
CN	12,599	0.9	0.3
ZA	12,449	0.0	0.0
MK	12,287	0.1	0.0
MV	11,954	0.9	0.0
GD	11,854	0.0	0.0
JO	11,496	0.0	0.0
PE	11,438	17.6	19.2

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
MN	11,396	0.0	0.0
TN	10,910	0.0	0.0
EC	10,849	11.0	20.2
LK	10,599	0.1	1.7
DM	10,377	0.0	0.0
LC	10,240	0.0	0.0
VC	10,234	0.0	0.0
AL	10,136	0.0	0.0
EG	10,049	0.0	0.0
ID	10,033	0.0	0.0

Raw Data: 101-150 Countries (GDP per Capita)

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
BA	9,699	2.8	4.5
NA	9,498	0.0	0.0
GE	8,742	0.0	0.0
PY	8,502	0.0	0.0
JM	8,470	0.0	0.0
FJ	8,388	0.0	0.0
UA	8,267	0.2	0.2
BZ	8,030	0.8	0.0
SV	7,967	0.0	0.0
SZ	7,911	0.0	0.0

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
AM	7,699	0.0	0.0
BT	7,456	0.5	0.2
MA	7,146	0.0	0.0
GT	7,112	0.0	0.2
PH	6,649	0.0	0.0
BO	6,325	2.7	3.8
CV	6,220	0.0	0.0
CG	5,988	0.0	0.0
NG	5,639	0.0	0.0
WS	5,523	0.0	0.0

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
IN	5,439	0.5	1.1
VN	5,370	0.0	1.0
UZ	5,317	0.0	0.0
LA	5,076	0.0	0.0
TO	4,972	0.0	0.0
MD	4,754	0.1	0.2
NI	4,692	0.0	0.0
HN	4,683	0.0	0.0
PK	4,590	0.0	0.0
PS	4,302	0.0	0.0

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
GH	3,894	0.0	0.0
SD	3,882	0.1	0.1
MR	3,732	0.0	0.0
ZM	3,725	0.0	0.0
MH	3,628	0.0	0.0
TV	3,592	0.0	0.0
FM	3,177	0.0	0.0
KG	3,169	0.0	0.0
DJ	3,120	0.0	0.0
KH	3,113	0.0	0.0

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
CI	3,108	0.0	0.0
ST	3,030	0.0	0.0
BD	2,979	0.0	0.0
VU	2,891	0.1	0.0
CM	2,836	0.0	0.0
KE	2,818	0.0	0.0
PG	2,723	0.0	0.0
TJ	2,567	0.0	0.0
LS	2,517	0.0	0.0
TZ	2,421	0.1	0.1

Raw Data: 151-194 Countries (GDP per Capita)

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
NP	2,265	0.0	0.0
SN	2,226	0.0	0.0
TL	2,125	0.0	0.0
TD	2,082	0.0	0.0
SB	2,032	0.0	0.0
BJ	1,937	0.0	0.0
SS	1,926	0.0	0.0
SL	1,876	0.0	0.0
AF	1,844	0.0	0.0
KI	1,726	12.0	0.0

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
ZW	1,709	0.0	0.0
UG	1,689	0.0	0.0
HT	1,652	0.0	14.0
RW	1,584	0.0	0.0
GM	1,556	0.0	0.0
BF	1,545	0.0	0.0
ML	1,526	0.0	0.0
ET	1,431	0.0	0.0
MG	1,373	0.0	0.0
KM	1,364	0.0	0.0

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
TG	1,363	0.0	0.0
GW	1,322	0.0	0.0
GN	1,165	0.0	0.0
MZ	1,077	0.0	0.0
NE	895	0.0	0.0
LR	804	0.0	0.0
MW	784	0.0	0.0
BI	734	0.0	0.0
CD	712	0.0	0.0
CF	567	0.0	0.0

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
LI	-	0.1	0.0
MT	-	0.0	0.0
BM	-	0.0	0.0
AD	-	0.0	0.0
MM	-	0.0	0.0
CU	-	0.0	0.0
SO	-	0.0	0.0
AO	-	0.0	0.0
GL	-	0.0	0.0
PR	-	0.0	0.0

Alpha2	GDP per Capita	% IPv6 BW	% IPv6 Penetration
GY	-	0.0	0.0
YE	-	0.0	0.0
AR	-	0.0	0.0
FO	-	0.0	0.0